



Setting time test on modification of alginate with addition of garut flour (*Maranta arunidaceae*)

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Abstract

Introduction: Alginate impression material is the most widely used impression material in dentistry. The availability of impression materials in Indonesia is highly dependent on importers, in some remote areas difficult to obtain and limited supplies. To overcome this situation, modification of the impression material is carried out by adding natural ingredients containing certain polysaccharides such as garut flour (*Maranta arunidaceae*).

Objective: The purpose of this study is to determine the effect of mixing alginate impression material with garut flour (*Maranta arunidaceae*) in terms of setting time.

Methods: The research method used experimental laboratories. The setting time value was calculated from the beginning of mixing the impression material until the impression material was no longer attached to the setting time indicator tool. Data were analyzed using ANOVA test followed by Post Hoc Tukey test.

Result and Discussion: The results of the ANOVA test showed that the p-value <0.05 indicates that the mixing of alginate impression material and garut flour has a significant effect on the setting time of the impression material.

Conclusion: The conclusion of this study is that the higher the percentage of garut flour added to the alginate impression material, the longer the resulting of setting time. The setting time for the modification of alginate and garut flour (*Maranta arunidaceae*) was according to the standard specifications of the American Dental Association (ADA) (2-4.5 minutes) for normal setting in the mixing groups D, E, and F.

Keywords: alginate, garut flour, setting time

Introduction

Impression material is a material to make an accurate replica / imitation / impression of oral tissue. Oral tissue consists of soft tissue and hard tissue. Hard tissue impressions can be used for single tooth or several teeth, partial jaws and teeth, jaws and all teeth or edentulous ridge. The result of impression material is in the form of a negative mold model, then filled with plaster model material to produce a positive mold model [1].

Alginate or irreversible hydrocolloid is an elastic impression material. The main active component of the irreversible hydrocolloid impression material is a water-soluble alginate, such as sodium, potassium or triethanolamine alginate [2]. Dentists prefer to use alginate as impression material because it is easy to use, easy to accept by patients, and has good hydrocolloid properties. In Indonesia, alginate impression materials are widely used with near-accurate results. However, because Indonesia imports alginate impression materials, its availability is highly dependent on importers [3].

The existence of rice flour, glutinous rice flour, corn flour and cassava flour is still limited to certain areas. And by considering the price of these flours in the market, the researcher feels the need to propose other materials with cheaper prices, easily available in the market as an alternative to a mixture of alginate impression materials. Garut flour contains high levels of carbohydrates and starch, consisting of 24.64% amylose and 73.46% amylopectin [4].

The ratio of amylose and amylopectin will affect the degree of starch gelatinization, the greater the amylopectin content, the gel produced from the starch gelatinization process will be wetter, sticky and tend to absorb less water.

The addition of natural materials to impression materials must have the same requirements as pure impression materials such as alginate, one of the things to pay attention to is setting time. Setting time is the time required to fulfill the setting reaction [5]. Based on the specifications of the American Dental Association (ADA) number 18, there are 2 types of setting time for alginate impression materials, which are divided into normal setting and fast setting according to the manufacturer's rules. Normal setting hardens less than 4½ minutes from the stirring process to the working process. Fast setting hardens between 1 to 2 minutes, the mixing process is 30 to 45 seconds and the working process is 1¼ minutes [6].

The purpose of this study is to determine the effect of mixing alginate impression material with garut flour (*Maranta arunidaceae*) in terms of setting time.

Methods

This type of research is an experimental laboratory with a post test only control group design. In this study, the samples were divided into six groups (table 1).

Table 1: Research Sample Groups.

No	Groups	The mixing ratio in each material	
		Alginate	Garut Flour
1	Group A	100% (4,2 grams)	0 % (0 gram)
2	Group B	55% (2,31 grams)	45% (1,89 grams)
3	Group C	52,5% (2,21 grams)	47,5% (1,99 grams)
4	Group D	50% (2,1 grams)	50% (2,1 grams)
5	Group E	47,5% (1,99 grams)	52,5% (2,21 grams)
6	Group F	45% (1,89 grams)	55% (2,31 grams)

This research was conducted at the pre-clinical laboratory of the Dental Nursing Department, Poltekkes, Kemenkes, Surabaya and was done in 2020. The method of collecting data for setting time in each group was by observation (calculated setting time with a

stopwatch). Written research procedures and explanations at each stage of manufacture, so that the same perception was obtained in making the research sample. Analysis of the data in this study used analysis software and was using the ANOVA test to see the difference in the effect of mixing on the modification of alginate impression material with garut flour on setting time. If there was a significant difference, it was continued with the Post Hoc Tukey test between each group.

Results

This study observed the effect of mixing garut flour on alginate impression material on setting time. The setting time value obtained is shown in the average setting time value as shown in Table 2.

Table 2: Average setting time of modification between alginate and garut flour.

Research groups	Average Setting time (Seconds) (mean \pm SD)	P-value	
Control Group			
A (100% : 0%)	77 \pm 4,41588	0,000*	
Kelompok Modifikasi			
B (55% : 45%)	108,8 \pm 6,26099		
C (52,5% : 47,5%)	114,4 \pm 6,58027		
D (50% : 50%)	122,4 \pm 6,02495		
E (47,5% : 52,5%)	125,4 \pm 6,22896		
F (45% : 55%)	137,8 \pm 9,31128		

*Significant p-value<0,05

Table 2 shows that the more garut flour mixture added to the alginate impression material, the greater average setting time obtained. Group A as the control group produced an average setting time of 77 seconds (1.2 minutes). Groups B and C produced an average setting time of 108.8 seconds (1.8 minutes) and 114.4 seconds (1.9 minutes) respectively, indicating that the three groups were faster than the ANSI/ADA specifications. NO. 18 of 1992, normal setting (2-4.5 minutes) alginate impression material. In groups D, E, and F, the average setting time was

122.4 seconds (2 minutes), 125.4 seconds (2.1 minutes), and 137.8 seconds (2.2 minutes). minutes) that meet ANSI/ADA standards. Table 4.1 also shows the ANOVA test which obtains a significant value of 0.000 ($p < 0.05$), which indicates that the mixing of alginate impression material and garut flour (*Maranta arundinaceae*) has a significant effect on the setting time of the impression material. To find out more about the differences between the research groups, the Post Hoc Tukey test was carried out.

Table 3: Tukey's Post Hoc Test Results between Research Groups.

Research Groups	P-value	
Group A	Group B	0,000*
	Group C	0,000*
	Group D	0,000*
	Group E	0,000*
	Group F	0,000*
Group B	Group A	0,000*
	Group C	0,763
	Group D	0,036*
	Group E	0,007*
Group C	Group F	0,000*
	Group A	0,000*
	Group B	0,763
	Group D	0,422
	Group E	0,130
Group D	Group F	0,000*
	Group A	0,000*
	Group B	0,036*
	Group C	0,422
	Group E	0,978
Group E	Group F	0,014*
	Group A	0,000*
	Group B	0,007*

	Group C	0,130
	Group D	0,978
	Group F	0,067
Group F	Group A	0,000*
	Group B	0,000*
	Group C	0,000*
	Group D	0,014*
	Group E	0,067

*Significant p-value<0,05

The results of the Post Hoc Tukey test in table 3 shows that there are significant differences in setting time values between each research group.

The setting time of the impression material is the time it takes from the mixing process of the material until the impression material hardens and is no longer attached. The setting characteristics of the impression material have an important influence on the ease of manipulation of the impression material. This can influence dentists in the selection of impression material products (McCabe and Walls, 2014). The American Dental Association (ADA) specification standard divides the setting time of alginate impression materials into two types, namely fast setting with a hardening time of 1-2 minutes and normal setting with a hardening time of 2-4.5 minutes^[6].

The results of this study indicate that there are differences in the value of setting time in each group. Group A is a control group using normal setting alginate impression material which requires a shorter setting time than the other groups. This is presumably because in group A pure alginate gelation reaction occurred, so that the setting time value of group A was the fastest compared to other groups. The alginate gelation process is the process of changing from a sol to a gel through a chemical reaction. When mixed with water, the reaction is described as a reaction between water-soluble alginate and calcium sulfate as a reactor and forms a water-insoluble calcium alginate gel. The formation of calcium alginate takes place quickly so that the setting time is quite short^[2, 7, 8].

Discussion

Garut flour has low amylose content and high amylopectin so garut is sticky when cooked^[4]. The high amylopectin content of garut flour has excellent adhesive ability so that it functions as an adhesive. In this study garut flour serves as a retarder that serves to extend the setting time^[8].

In the gelation process of pure alginate impression material, the addition of sodium phosphate acts as a retarder to slow down the setting time. The reaction of water-soluble calcium sulfate is slowed down in the presence of sodium phosphate. Calcium sulfate will first react with sodium phosphate. After the sodium phosphate is depleted, calcium ions will react with potassium alginate to form calcium alginate which is insoluble in water^[2, 9, 10].

This study showed that the setting time of groups A, B, and C was faster than the normal American Dental Association (ADA) specification for setting alginate impression materials. Groups D, E, and F produced a setting time in accordance with the specifications of the American Dental Association (ADA) for normal setting of alginate impression material. The temperature of the mixing water is also thought to be a factor affecting the setting time. The temperature or water temperature can control

the process of setting time on the impression material. In this study, mixing water with a temperature of 30°C or the same as room temperature was used, so that it is expected to produce a faster setting time. Situational factors, namely the intensity of stirring can be another factor that affects the setting time. The greater the intensity of stirring in one minute, the faster the resulting setting time and vice versa^[9, 11]. Incomplete stirring causes the mixture to be mixed evenly so that the reactions that occur are not uniform and the resulting setting time varies. Stirring too long can break the calcium alginate gel webbing and reduce its strength. In this study, stirring was carried out with a maximum time of 20 seconds from the mixing process^[5].

Table 2 shows significant results, which means that there is an effect of mixing alginate impression material with garut flour on the setting time. The presence of polysaccharides in garut flour is thought to slow down the reaction process of the alginate impression material which results in different setting times in each group. Garut flour inhibits the hydration process of alginate by releasing hydroxyl groups^[12]. Garut flour contains high amylopectin which causes garut to be sticky. While the low amylose content in garut flour causes the water absorption process to occur is low and slow^[4]. It is possible that it can affect the setting time of modification of alginate impression material and garut flour. Based on the specifications of the American Dental Association (ADA) No. 18 of 1992, the normal setting of alginate has a setting time of 2-4.5 minutes. The results of this study obtained an average setting time of at least 77 seconds (1.2 minutes) and a maximum of 137.8 seconds (2.2 minutes). The final results of this study generally showed that the modification of garut flour and alginate in groups D (2 minutes), E (2.1 minutes) and F (2.2 minutes) met or complied with the normal American Dental Association (ADA) specification standards. alginate impression setting^[9].

Conclusion

Based on the results of the research that has been carried out, it can be concluded that the setting time of the alginate impression material will be slower the more the percentage of garut flour (*Maranta arundinaceae*) is added. The setting time of modification of alginate and garut flour (*Maranta arundinaceae*) according to the American Dental Association (ADA) specification standard (2-4.5 minutes) normal setting of alginate impression material in the D, E, and F mixing groups.

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